



WATER RESOURCES RESEARCH GRANT PROPOSAL

Title: ENHANCED BUBBLE AND WAVE-MEDIATED AERATION OF TREATMENT AND NATURAL WATERS

Duration: September 1 1997 To August 31, 1998

Federal Funds: \$34,985

Non-Federal Funds: \$69,970

Principal Investigator, University, City: Steve R. Duke, Auburn University, Auburn, AL

Congressional District: #3

Water Problem and Need for Research:

Fisheries and aquatic ecosystems are damaged by poor DO (dissolved oxygen) levels in rivers, lakes, and streams. DO is consumed by fish for respiration and by microorganisms for oxidation processes. DO is replenished by the transport of oxygen across air-water interfaces, and these interfaces take the form of bubbles and waves. Models commonly accepted by the EPA for predicting and monitoring oxygen replenishing rates are characterized by relative errors of more than 100%. If oxygen transport rates are under predicted, then DO levels drop; oxidation and respiration processes slow down or cease.

Aeration accounts for half of the capital and energy costs for treatment of industrial wastewater to provide DO and BOD levels at the current water quality standards. Advanced treatment practices and control will be required to meet the new Cluster Rule wastewater standards for BOD and DO with economic efficiency.

Expected Results, Benefits, Information, etc.:

This research seeks to understand the interfacial phenomena and physical mechanisms that govern transport of oxygen across waves and bubbles in air-water systems. Support is requested for graduate and undergraduate student research efforts to develop and demonstrate an innovative laser-induced fluorescence technique to image dynamic oxygen concentration fields. Results will provide instantaneous spatially-varying images of concentration gradients occurring during aeration within thin boundary layers near the interfaces of transport. Studies are proposed at different wave conditions (mechanical and wind-generated) and at different bubbling conditions. The images will allow us to identify and quantify local regions of high and low transfer rates; the rate variations can be directly related to the interfacial characteristics and flow fields responsible for them.

Advanced design of wastewater treatment aerators can exploit the waves and bubbles that are found to give the largest and most efficient transport rates. EPA models for monitoring and predicting DO and BOD in discharge and receiving waters can be strengthened by basing them on physical and mechanistic understanding of gas-exchange phenomena, rather than relying on empirical relations. The research projects outlined in this proposal demonstrate the feasibility and usefulness of using laser-induced fluorescence imaging to study aeration processes. Images from the project will be used to request future funding for improved equipment and further systematic studies of enhanced aeration at waves and bubbles.